ACS and Heart Failure
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Learning Objectives
• Establish the diagnosis and therapy of acute coronary syndrome.
• Formulate the indications for fibrinolysis, glycoprotein IIb/IIIa agents, and angioplasty in acute coronary syndrome.
• Analyze the difference between systolic and diastolic cardiac dysfunction.
• Differentiate the therapies that increase the chance for survival in patients with heart failure and those that only improve symptoms.
• Review the role of neurohormonal activation in systolic heart failure.

Acute Coronary Syndrome
• Acute coronary syndrome
  – Unstable angina (UA)
  – Non-ST-elevation myocardial infarction (NSTEMI)
  – ST-elevation myocardial infarction (STEMI)

1. A 52-year-old man presents to the ED with a 45-minute history of squeezing substernal chest pressure radiating to his left arm.

An ECG from a routine physical two months ago was normal.

Question 1 ECG

1. This patient’s history and ECG are most consistent with which one of the following?
   A. Esophageal spasm
   B. Acute ST segment elevation MI (STEMI)
   C. Acute non-ST segment elevation MI (NSTEMI)
   D. Pericarditis
1. This patient’s history and ECG are most consistent with which one of the following?

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ECG Findings: ST Segment Depression, Inferior and Lateral Precordial Leads

Acute Coronary Syndrome

- UA and NSTEMI are closely related, with similar presentations, but with differing severity:
  - Both cause ST-segment depression or prominent T-wave inversion
  - Ischemia severe enough to cause myocardial injury with release of biomarkers (troponin I, troponin T, CK-MB) = NSTEMI
- STEMI is distinguished from UA/NSTEMI by presence of ST-segment elevation on EKG (followed by Q wave)
  - Warrants immediate reperfusion therapy

Acute Coronary Syndrome

- Etiology: reduced myocardial perfusion
  - Reduced O₂ supply (more common)
  - Increased O₂ demand

Acute Coronary Syndrome

- Most commonly due to occlusive thrombus developing on top of a disrupted atherosclerotic plaque
  - Nearly 50% at sites with < 50% luminal narrowing
- Other etiologies:
  - Spasm at site of atherosclerotic plaque
  - Normal coronary arteries with spasm
    - Prinzmetal’s angina; transient ST elevation associated
  - Arterial inflammation (Kawasaki disease)
  - Cocaine-induced (treat with NTG and CCB)

2. This patient’s initial troponin is normal. Which of the following statements about cardiac biomarkers is correct?

A. A single negative troponin excludes MI
B. Troponin is a better marker of reinfarction than is CK-MB
C. Myoglobin can be detected as early as 2 hours after the onset of myocardial necrosis
D. CK-MB and myoglobin rise and fall more slowly than troponin
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Troponin
- Troponin is the biomarker of choice in the evaluation of ACS. Troponin I and T are equivalent.
- Detected 3-6 hours after the onset of ischemic symptoms
- Normal serial troponin levels exclude myocardial infarction, but do not exclude unstable angina.
- Troponin remains elevated for 7-14 days post-MI

Myoglobin
- Earliest marker of MI
  - released from damaged muscle more rapidly than CK-MB or troponin
  - can be detected as early as 2 hours after cardiac necrosis
  - Peaks at about 8 hours; remains elevated < 24 hours
- Sensitive but not specific.
  - Cardiac origin must be confirmed with a more cardiac-specific enzyme
  - false positives due to skeletal muscle injury

CK-MB
- Remains elevated for 36-48 hours following MI
- Early peak (12-18 hours) suggests reperfusion
- CK-MB and myoglobin rise and fall more rapidly than troponin
  - better for diagnosing reinfarction

3. This patient continues to have pain despite treatment with IV NTG, morphine, β-blocker, aspirin and heparin. A repeat ECG shows persistent ST segment depression. What is the next most appropriate intervention?

- A. Emergency PCI (percutaneous coronary intervention)
- B. Fibrinolysis
- C. Emergency CABG
- D. Glycoprotein IIB/IIIa agent

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2007 ACC/AHA UA/NSTEMI Guideline Revision

- Recommends initial invasive strategy in patients with the following characteristics:
  - Recurrent angina or ischemia at rest or with low-level activities despite intensive medical therapy
  - Elevated cardiac biomarkers (TnT or TnI)
  - New or presumably new ST-segment depression
  - Signs or symptoms of HF or new or worsening mitral regurgitation
  - High-risk findings from noninvasive testing

- Hemodynamic instability
- Sustained ventricular tachycardia
- PCI within 6 months
- Prior CABG
- High risk score (e.g., TIMI, GRACE)
- Reduced left ventricular function (LVEF less than 40%)

ACS Therapy: Fibrinolysis

- Fibrinolytic therapy or primary percutaneous coronary intervention (PCI) should be strongly considered in all STEMI patients with a symptom onset within 12 hours
  - tPA or reteplase (Retavase): heparin is given to increase the likelihood of patency in the infarct-related artery
  - Streptokinase or APSAC: heparin does not offer any additional benefit

ACS Therapy: PCI with Stent

- Bare metal
  - Bare metal acts as foreign body, increasing risk of in-stent thrombosis – clopidogrel + ASA decreases risk; continue 1 month post-stent if no MI (or 12 months if post-MI)
  - Epithelialization may progress to in-stent stenosis
- Drug-eluting
  - Delay epithelialization, maintaining bare metal longer; continue clopidogrel + ASA for 12 months
  - Sirolimus (Cypher), Tacrolimus (Mahoroba), Paclitaxel (Taxus)

ACS Therapy: Emergency CABG

- Considered only if coronary anatomy is not suitable for PCI

ACS Therapy: Glycoprotein IIb/IIIa Inhibition

- Glycoprotein IIb/IIIa receptor blockers
  - Inhibit platelet aggregation
  - Tirofiban (Aggrastat), Eptifibatide (Integrilin)
    - Further reduce the incidence of ischemic events in patients with NSTEMI, when administered with heparin and aspirin
  - Abciximab (ReoPro)
    - Reduces the risk of closure after angioplasty
4. A 70-year-old woman with history of hypertension and type 2 diabetes presents to the ED with a 14-hour history of profound shortness of breath, but no chest pain.

Her current medications include HCTZ, lisinopril and insulin.

4. This patient’s history and ECG are most consistent with which one of the following?

A. Unstable angina
B. Acute anterior wall ST segment elevation myocardial infarction
C. Pericarditis
D. Acute anterior wall ischemia

ECG Findings
Q waves and ST segment elevation with T-wave inversion, anterior precordial leads (V₂ – V₅)

ACS: STEMI
ST segments:
- Elevation occurs immediately post plaque-rupture and is consistent with myocardial injury.
- Resolution of ST elevation suggests reperfusion.
- Persistent ST elevation may be seen with aneurysm formation.
- ST depression indicates myocardial ischemia.

Q waves:
- Develop approximately 12 hours post plaque-rupture, and are indicative of (electrically) dead myocardium (MI).
- Typically permanent.
ACS: STEMI

• Anterior/Anteroseptal
  – LAD
  – Leads V₁ – V₄
• Lateral
  – Circumflex
  – Leads V₅ – V₆
• Inferior
  – RCA
  – Leads II, III, aVF

5. Which of the following medications improves survival post-MI?

A. Digoxin
B. Dihydropyridine calcium-channel blocker
C. Long-acting nitrate
D. ACE-inhibitor

Post-MI Survival

• ACE-inhibitors, β-blockers, statins and ASA improve survival post MI.

• Nitrates, clopidogrel, calcium-channel blockers and digoxin may improve symptoms, but do not affect survival.

6. Which one of the following statements regarding systolic heart failure is correct?

A. Left ventricular ejection fraction is < 40%.
B. Systolic dysfunction produces different symptoms than diastolic dysfunction.
C. Systolic dysfunction results from increased ventricular stiffness.
D. Systolic dysfunction and diastolic dysfunction do not coexist in the same patient.
Systolic Heart Failure

- Systolic dysfunction: ejection fraction < 40%
- Systolic dysfunction may produce the same symptoms as diastolic dysfunction.
- Diastolic dysfunction results from increased ventricular stiffness and decreased ventricular compliance.
- Both systolic and diastolic dysfunction may be present in the same patient.

Systolic Heart Failure Treatment

Low cardiac output triggers neurohormonal activation, which ultimately results in premature apoptosis of cardiac myocytes.

- Preload reduction
  - Diuretics, nitrates
- Afterload reduction
  - ACEI, ARB, hydralazine, nitrates
- Sympathetic blockade
  - ß-blockers
- Aldosterone-antagonist therapy
  - Spironolactone, eplerenone (Inspra)

7. Which one of the following is considered a contraindication to the use of ß-blockers for congestive heart failure?

A. Mild asthma
B. Symptomatic heart block
C. New York Heart Association (NYHA) Class III heart failure
D. NYHA Class I heart failure in a patient with a history of a previous myocardial infarction
E. An ejection fraction <30%

ß-blockers and Heart Failure

- Mortality rates are improved in HF patients who receive ß-blockers in addition to diuretics and ACEIs.
- ß-blockers are effective in patients with NYHA Class II or III heart failure.
- There is no absolute threshold ejection fraction.
- ß-blockers decrease mortality in patients with prior MI, regardless of NYHA classification

ß-blockers and Heart Failure

- Contraindications to ß-blocker use include:
  - Hemodynamic instability
  - Heart block
  - Bradycardia
  - Severe asthma
- ß-blockers may be initiated in patients with mild asthma or COPD, as long as they are monitored for potential interactions
ß-blockers and Heart Failure

- ß-blockers should be started when the patient is stable and euvolemic.
- ß-blocker benefit is a drug-specific effect, not a class effect. Proven ß-blockers include:
  - Metoprolol succinate
  - Carvedilol
  - Bisoprolol

8. Which one of the following is preferred for chronic treatment of congestive heart failure due to left ventricular systolic dysfunction?

A. Diuretics
B. Digoxin
C. Calcium channel blockers
D. ACE inhibitors
E. Hydralazine plus isosorbide dinitrate

ACE-Inhibitors and Heart Failure

- ACEIs are preferred for CHF due to LV systolic dysfunction because they offer the greatest reduction in mortality.

Other Treatments for Heart Failure

- Hydralazine/isosorbide is a reasonable alternative.
- Diuretics typically should not be used as monotherapy.
- Digoxin may help with symptoms and decreases hospitalizations, but has not been proven to affect mortality. Aim for a serum level of ≤1.0 ng/mL

9. A 70-year-old woman with hypertension presents with progressive dyspnea. Rales at the lung bases are noted, and chest x-ray shows pulmonary edema with a normal size heart. Which of the following statements is true?

A. Viral cardiomyopathy presents with diastolic dysfunction.
B. Treatment of diastolic heart failure requires high-dose diuretics.
C. The ejection fraction with diastolic heart failure is > 40%.
D. Digoxin therapy should be considered in the majority of patients with diastolic heart failure.
9. A 70-year-old woman with hypertension presents with progressive dyspnea. Rales at the lung bases are noted, and chest x-ray shows pulmonary edema with a normal size heart. Which of the following statements is true?

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C. The ejection fraction with diastolic heart failure is > 40%.
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Diastolic Heart Failure

- RCTs specifically evaluating therapy for diastolic heart failure are limited.
- Patients tend to be volume sensitive and can develop hypotension with excessive diuresis.
- If rapid atrial fibrillation/flutter is present, digoxin is indicated for rate control.
- Careful preload reduction is appropriate.
- Careful decrease in heart rate, using β-blocker or non-dihydropyridine CCB is appropriate.

10. A 56-year-old male with longstanding hypertension and a 30-pack-year smoking history has a 2-day history of dyspnea on exertion. Physical examination is only notable for rare crackles at the bases. Which one of the following serologic tests would be most helpful for detecting left ventricular dysfunction?

A. Brain-natriuretic peptide (BNP)
B. Troponin-T
C. C-reactive protein
D. D-dimer
E. Cardiac interleukin-2

BNP and Heart Failure

- BNP is secreted from the ventricles in response to ventricular volume expansion and pressure overload.
- Release is directly proportional to ventricular dysfunction and correlates with end-diastolic pressure.
- BNP undergoes partial renal excretion; levels are inversely proportional to creatinine clearance.

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References: ACS / Heart Failure


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Answers

1. C
2. C
3. A
4. B
5. D
6. A
7. B
8. D
9. C
10. A